

Increasing Confidence in Your Decisions"

NASA Project Management
Challenge
March, 2005

Presented by:

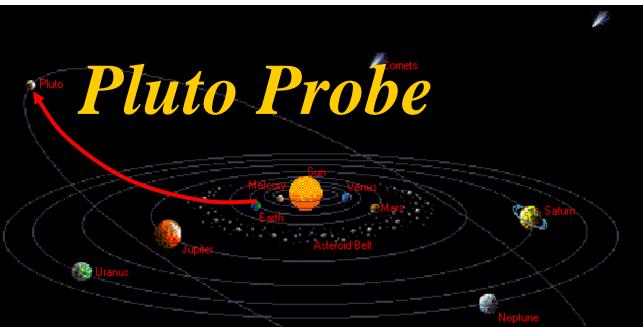
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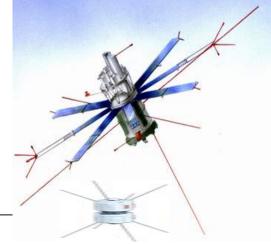


You are the manager of a hypothetical 2nd Mission to Pluto which will penetrate Pluto's frozen atmosphere*

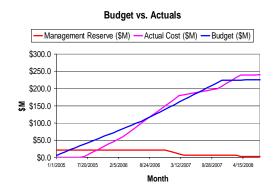


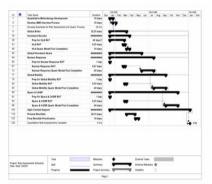
- Two launch windows in 2008
- Probe will arrive at Pluto around 2020
- Probe will partially map solar wind in our solar system during journey
- Program Cost is around \$300M
- Uses Delta-4 Launch Vehicle





Initial Management Plan for the Pluto Mission

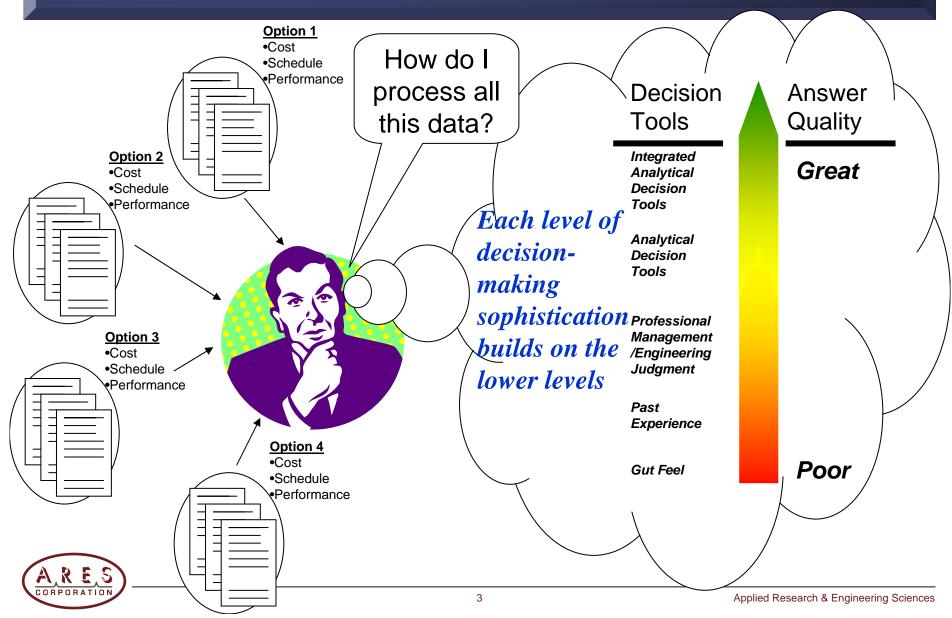




- Have already determined the "baseline plan" to meet the stated cost, schedule, and performance goals
- As managers, how do we now optimize the cost, schedule, and performance of this new Program?

- Things are not going to go completely according to plan
 - Introduces uncertainty
 - Many options to fix the things that went wrong
 - That's what management reserves are for, but they are limited
- Need to make critical management decisions during planning and operational phases to handle all of the possible options
 - Need to gather and interpret many different inputs to come up with integrated solutions
 - Must trade-off between cost, schedule, and technical performance gains

Decision-Making 101



The True Value of Analytical Decision Tools

Analytical decision tools give decisionmakers higher confidence in decisions than "gut feel" or "professional experience" alone

- Analyzes inputs from disparate sources for integrated results
- Decisions are defensible and traceable



Which Tools Should I Use?

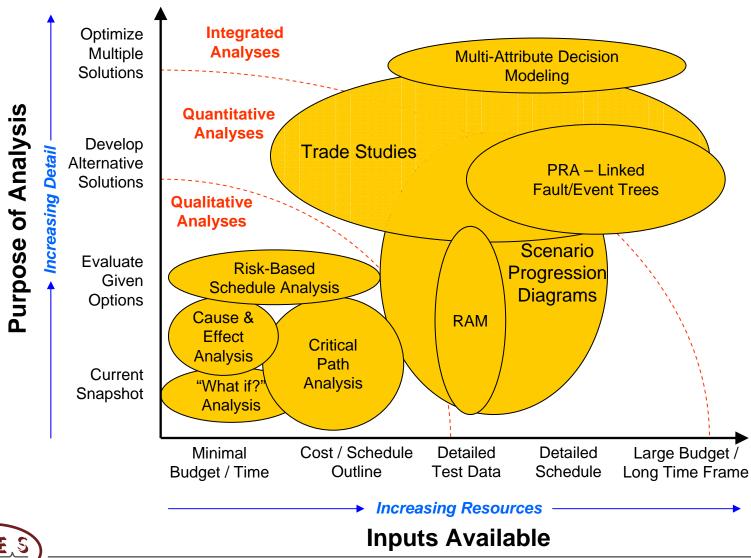
The Analytical Decision Tools you use are highly dependent on your management needs

- What outputs do you need?
 - Cost of options vs.
 baseline
 - Schedule to complete options vs. baseline
 - Technical Performance of each option vs. baseline
 - Integration of all of the above for each option compared against the baseline

- What resources are available for your analyses and what constraints are you under?
 - Management
 Constraints/Resources
 - Time
 - Money
 - People
 - Information Resources
 - Budget Plans and Cost Estimates
 - Schedule Plans and Estimates
 - Technical and Engineering Studies
 - Vendor Data



Which Tools Should I Use?





Key Concepts

Risk Assessment

- What can go wrong?
- How likely is it to occur?
- What are the consequences?

Probabilistic Analysis

Analytical study of likelihood, probability, and/or uncertainty

Trade Studies

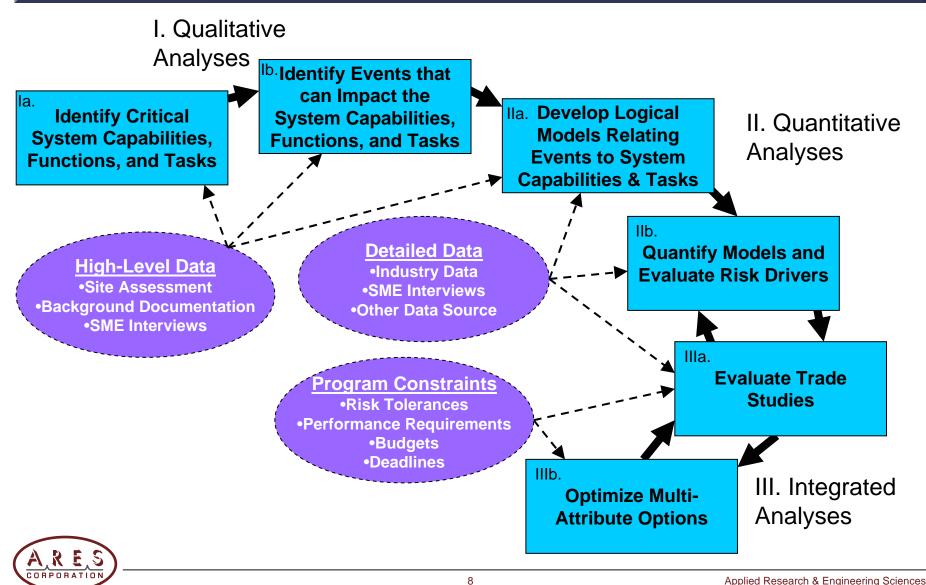
Evaluation of options and comparison against a baseline plan

Multi-Attribute Optimization

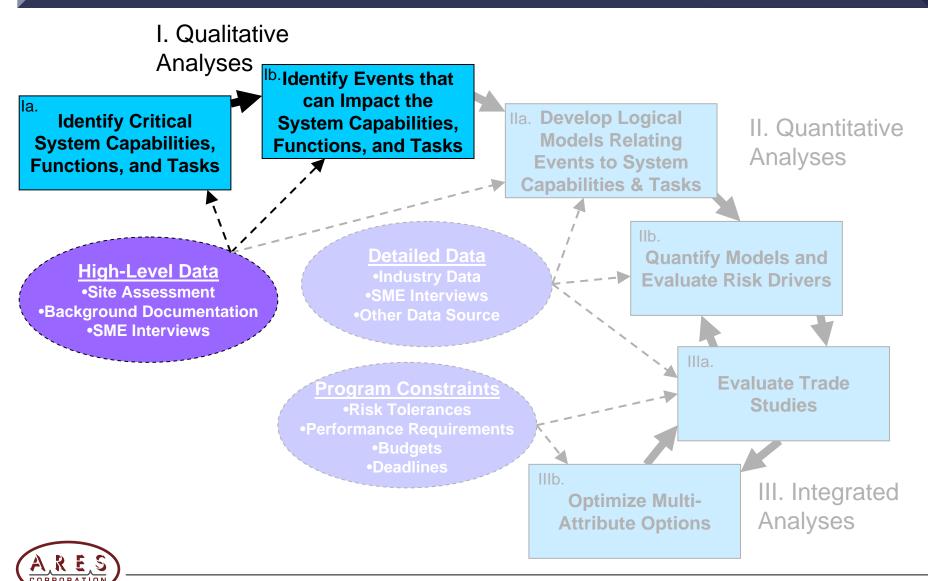
- Analytical derivation of the optimal combination of cost, schedule, and technical performance
- OR Analytical processes used to determine the combined maximums and minimums of sets of desired functions while adhering to sets of constraints



Analysis Development



Qualitative Analyses



Identify Critical System Capabilities, Functions, and Tasks

Critical Functions

- Scientific Instruments
 - Gas/Particle Collection Assembly
 - Surface Mapping System
 - Cameras
 - Scientific Data Processing and Memory
 - CCDs & Other Detectors
- Spacecraft Systems

 Thermal Control

 - Guidance, Navigation, & Control/Propulsion
 - Communication
 - Electrical Power/Solar Panels
 - Control & Data Handling
 - Structure/μ-Meteoroid Shielding
- Launch and Ground Systems
 - Launch Vehicle
 - Command Center and Data Links
 - TDRSS

Critical Tasks

- System Development Design through Láunch Preparation
 - Develop Mission Concepts
 - Down-Select Procedure
 - Determine Final Design and Contractors
 - Contractor 1 Develops System 1
 - Contractor 2 Develops Systems 2 & 3

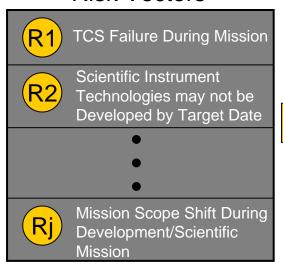


- Contractor N Develops System M
- Laboratory Develops Sciéntific Instruments
- Component/System Testing
- System Integration and Testing
- Payload/System/Launch Vehicle Integration and Testing
- Program Reviews (FRR, PAR, etc.)
- Final Countdown
- Mission Tasks
 - Launch and Deployment
 - Maneuvers to Pluto
 - Solar Wind Observation
 - Pluto Science Mission
 - "Safe" Spacecraft and End Mission



Identify Events That Can Impact the System Capabilities, Functions, and Tasks

Risk Vectors

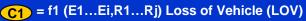


- Risk Dependency Matrix
 captures the interdependencies
 of the risks among the critical
 functions, tasks, budget, and
 schedule
- Risks are mapped to Consequence Categories based on expected impact to program



I	Functions Tasks	Thermal Control System	Electrical Power System	• • •	Comm.
	Contractor 1 Develops System 1	R6			Rj
,	Laboratory Develops Sci- Instruments		Rj	R2, R13	Rj
	Payload/ System Integration			R7, R37, Rj	
	•				
	Pluto Science Mission	R1	R5, R43, Rj		R16





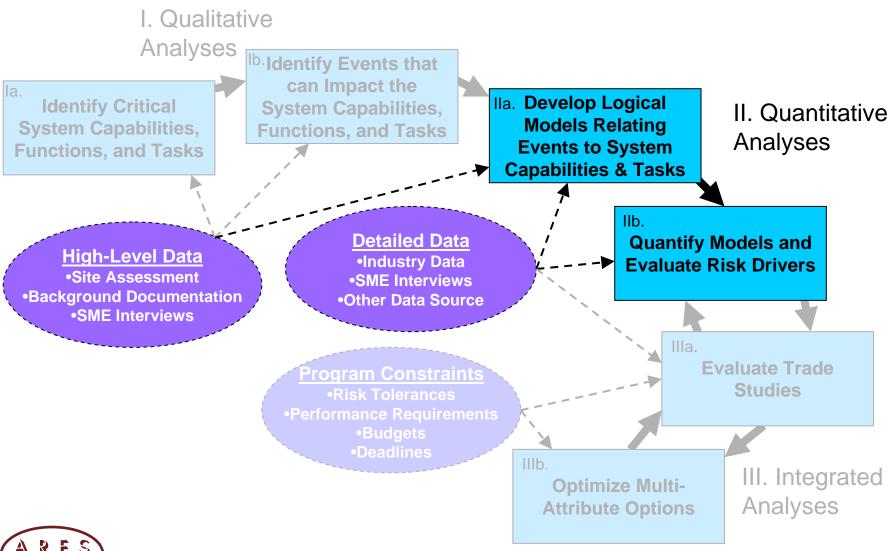
C2 = f2 (E1...Ei,R1...Rj) Mission Failure (LOM)

Ck-1) = fk-1 (E1...Ei,R1...Rj) Launch Window Missed

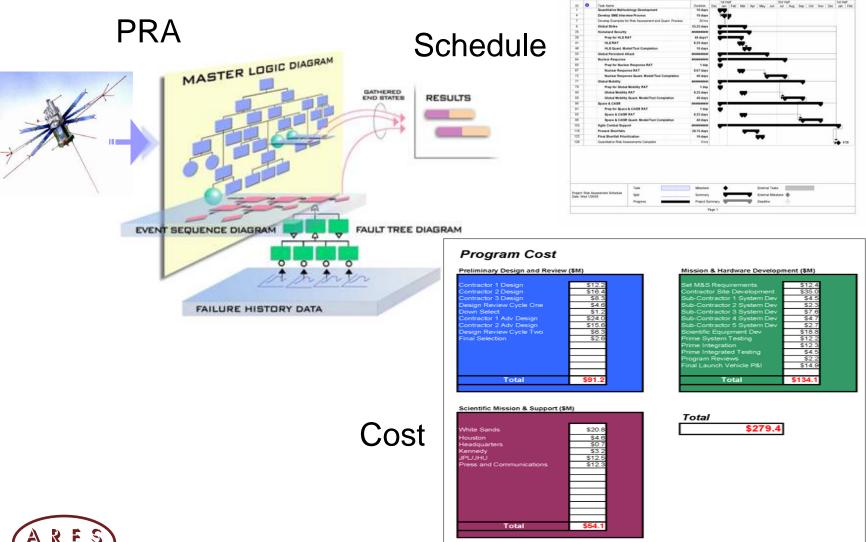
Ck = fk (E1...Ei,R1...Rj) Program Over Budget



Quantitative Analyses

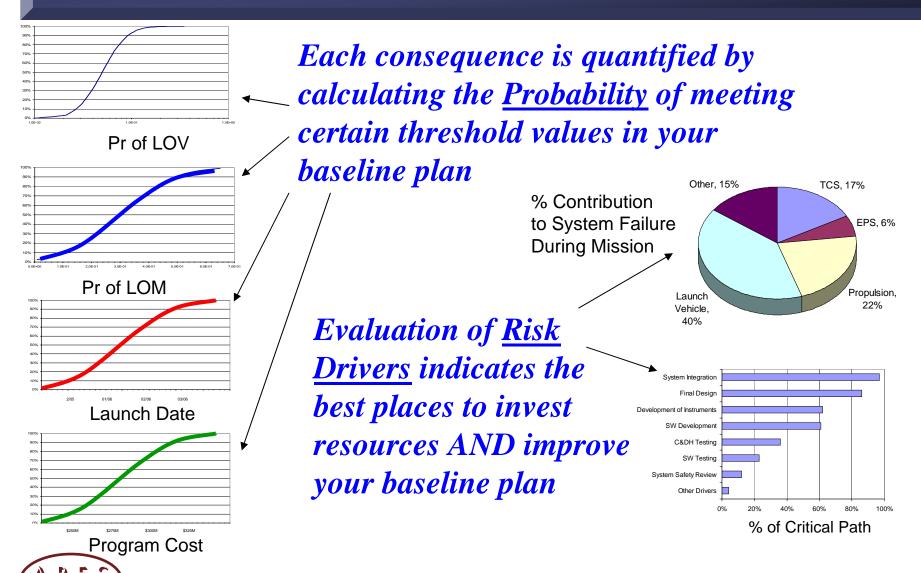


Develop Logical Models Relating Events to System Capabilities & Tasks

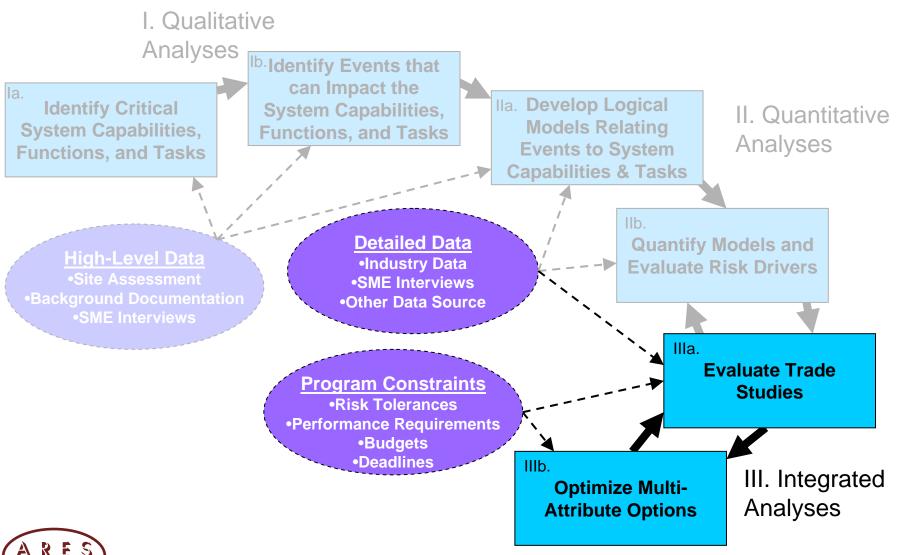




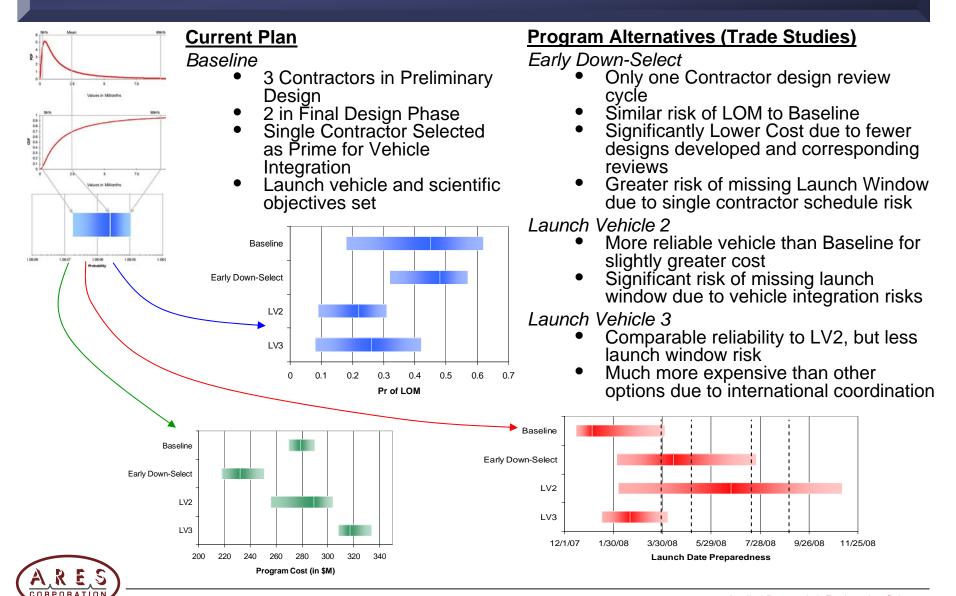
Quantify Models and Evaluate Risk Drivers



Integrated Analyses

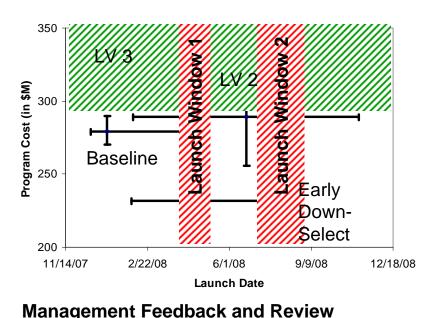


Evaluate Trade Studies



Optimize Multi-Attribute Options

Launch Date vs. Cost

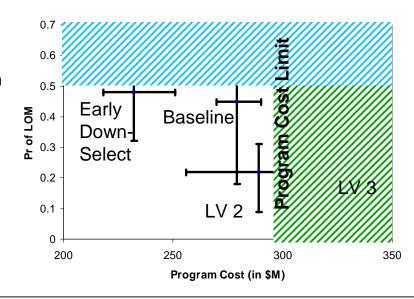


- Upon management review, LV2 poses too much launch window risk
- Identify more options for Early Down-Select that reduce missed launch window risk
- Need to evaluate Early Down-Select with LV3 option for balancing of cost and schedule
- Identify more options for LVs with high reliabilities
- Identify other options
 - Modify Science Objectives
 - Alternative Propulsion Technologies

Preliminary Conclusions

- Most options overlap with cost, schedule, and LOM acceptance criteria
- Baseline designed to meet Cost and Schedule, but does not optimize overall solution
- LV3 by itself not really an option due to cost constraints on program
- Early down-select possibly best option due to reasonable LOM risk, reduced cost, and low risk of missing final launch window
- NO CLEAR WINNER(S); Further evaluation needed to make final decisions

Cost vs. Loss of Mission





Summary

- Analytical Decision Tools give decision-makers higher confidence in decisions than "gut feel" or "professional experience" alone
- Analytical Decision Tools can be applied by managers to:
 - Perform broad and/or focused analyses...
 - Integrate data from multiple sources...
 - Provide immediate or long-term answers... ... for Programs of all sizes
- Analytical Decision Tools add value to managerial decisions by providing analytical fidelity to the process of decision-making

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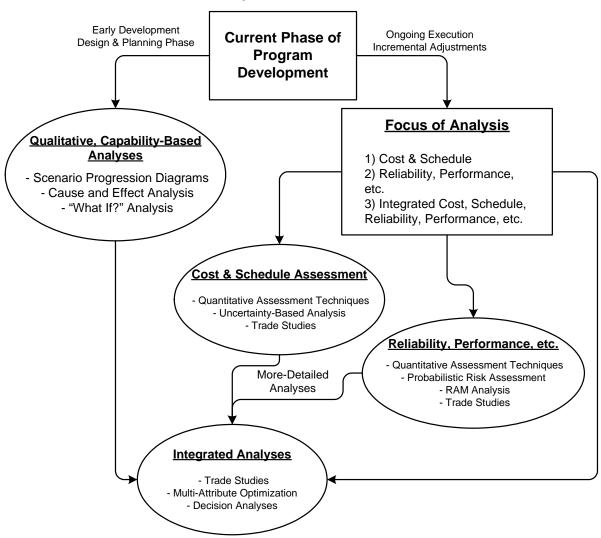






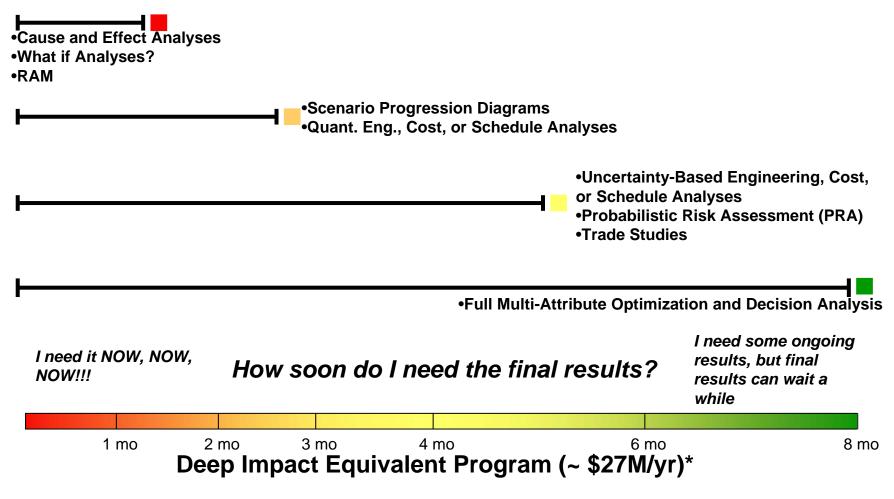
What Output Do You Want?

Risk Analysis and Assessment Tools





Analysis Completion Timeline



What do I Need for These Analyses?

Probabilistic Risk Assessment

- System and Mission Requirements
- Existing Engineering Studies and Analyses
- Vendor, Engineering, and Test Data
- Engineering Team Support and review for PRA data and logic

Schedule Analysis

- Existing WBS for Program *OR*
- Develop WBS with Analysis team
- Identify Cost/Schedule Řisks to Tasks and/or RM Database
- Management review of Cost/Schedule/Task risk logic

Cost Analysis

- Existing Costing info for Program *OR*
- Develop Program Cost with Analysis team Identify Cost/Schedule Risks to Tasks and/or RM Database
- Management review of Cost/Schedule/Task risk logic

